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THE TEACHER, PROGRAMED MATERIALS, AND INSTRUCTIONAL INTERACTION--AN ASSESSMENT OF FIVE SELECTED CONDITIONS OF TEACHER AND PROGRAM INTEGRATION. FINAL REPORT.

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FIVE DIFFERENT TEACHING STRATEGIES WERE INVESTIGATED IN UTILIZATION OF PROGRAMED INSTRUCTIONAL MATERIALS FOR FIRST-YEAR ALGEBRA. TEACHERS USED EITHER TRADITIONAL ALGEBRA OR A MODERN MATH PROGRAM. TEACHING CONDITIONS RANGED ON A CONTINUUM FROM RIGID CLASSROOM ORGANIZATION AND TEACHER-CONTROLLED STUDENT PACE TO FLEXIBLE ORGANIZATION AND STUDENT-DETERMINED PACE. AT THE END OF THE YEAR, THERE WERE NO SIGNIFICANT DIFFERENCES AMONG CONDITIONS IN STUDENT ACHIEVEMENT, IN STUDENT ATTITUDE TOWARD MATHEMATICS OR PROGRAMED INSTRUCTION, OR IN TEACHER ATTITUDE TOWARD PROGRAMED INSTRUCTION, INDIVIDUALIZATION OF INSTRUCTION, AND EDUCATIONAL RESEARCH. TEACHER ATTITUDE AFFECTED STUDENT ACHIEVEMENT. TEACHERS TENDED TO MAKE MORE UNFAVORABLE COMMENTS ABOUT THOSE TEACHING CONDITIONS WHICH DEPARTED FROM THE TRADITIONAL MODES. READING SCORES WERE THE BEST PREDICTOR OF MATH ACHIEVEMENT. IT WAS FOUND THAT PROGRAMED INSTRUCTION CAN BE USED IN AT LEAST FIVE DIFFERENT WAYS WITHOUT SIGNIFICANTLY ALTERING STUDENT ACHIEVEMENT OR ATTITUDE, AND THAT BOTH STUDENTS AND TEACHERS CAN DEPART FROM CONVENTIONAL MODES OF INSTRUCTION. THE SIGNIFICANT FINDING WAS THAT NO ONE CONDITION WAS OUTSTANDING, THAT EACH CONDITION HAD A HIGH PAY-OFF FOR SOME TEACHERS AND STUDENTS--FOR OTHERS, THE SAME CONDITION WAS AN ABOMINATION. (BB)

FINAL REPORT

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AN ASSESSMENT OF FIVE SELECTED CONDITIONS OF TEACHER AND PROGRAM INTEGRATION

May 1967

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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THE TEACHER, PROGRAMED MATERIALS, AND INSTRUCTIONAL INTERACTION: AN ASSESSMENT OF FIVE SELECTED CONDITIONS OF TEACHER AND PROGRAM INTEGRATION

Project No. 1120
Grant No. 7-48-0000-215

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
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ACKNOWLEDGMENTS

One of the avowed purposes of this project was to demonstrate that a number of educational organizations can effectively cooperate in a concerted effort to resolve a common problem. In this study, with major support and sponsorship of the Office of Education, a state education department, a university, a state college, an area curriculum committee, seven county school offices, and 63 public school districts successfully accomplished this.

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INTRODUCTION

Problem and Related Research

In the early 60's, there were many testimonies concerning the promise and potential of programed instruction, but few endorsements as to the most effective and efficient process by which to combine the teacher and the program into an instructional team that was, in combination, superior to either the teacher or the program alone.

Indeed, the most frequent plea in the literature followed the tenor of Moore (1962) when he wrote, "...the most meaningful way in which they (programed materials) can be implemented still remains to be demonstrated." Two years prior to Moore's statement, Komoski (1960) wrote, "The question which educators must answer is how will it (programed materials) be used?" Wohlwill (1962) also questioned, "...of what this place should be and how these instruments can be most effectively used and integrated with other forms of instruction still need much closer scrutiny." Dick and Heimer (1962) supported Wohlwill when they stated that, "There are a multitude of questions that must be answered relative to school utilization of programed materials if they are ever to attain their full potential of contributing to more effective techniques of teaching and/or learning."

Probably the best summary of the problem was given by Deterline (1962). "Programed instruction introduces real problems while solving others. The 'system'[1] question becomes the responsibility of the proponents of programed instruction, and so far this responsibility has not been accepted, nor the problem solved."

The situation was little improved by 1965 when Glaser edited Teaching Machines and Programed Learning, II. There were only three short references to the teacher's role in the use of programed instruction in Glaser's 800-page volume.

As recently as 1967 when Part II of the NSSE Yearbook, entitled Programed Instruction, appeared, only one reference to "...possible applications of programed instruction to classroom instruction" was found, and three for "changing teacher role."

Why has this area of classroom utilization and implementation been neglected? Basically, because there were some fundamental questions needing careful attention, i.e., response mode, sequencing,

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[1] Deterline uses the term "system" to describe the procedure and process by which program and teacher combine as an instructional unit.

prompting and confirmation methods, branching, pacing, and repetition (Silberman, 1962) and because investigations of teacher utilization have been severely limited by the conditions necessary for the development and refinement of programed materials (Gotkin, 1962).

The Dimensions of Teacher-Program Integration and Interaction

"And what are the most potent combinations of programed instruction with other teaching to accomplish given educational goals?" (Schramm, 1962) Apparently neither Schramm nor other authorities could supply the appropriate answer. Deterline (1962) indicated that in the early developmental phase of programed instruction, only two extreme positions were considered--all program, no teacher, or all teacher, no program. Consequently, programed instruction was seen to be an all-or-none possibility. The only possible alternative to "all-or-none" was the complete rejection of programed instruction in favor of conventional 100% teacher-taught classes. One end of the continuum was perceived as being

1) all teacher, textbook, NO program

and the other extreme consisting of

2) all program, NO teacher, NO textbook.

There have been many comparative studies made between these two extremes and, although there are limitations inherent in these comparisons, the general conclusion is that the program does teach and, in some cases, as effectively and more efficiently as conventional instruction (Silberman, 1962; Stolurow, 1961; Glaser, 1965). It was not the intent of this study to again make this comparison, but to propose several points between these extremes that appear to be more realistic, manageable, and meaningful for school and teacher utilization.

It was the specific purpose of this study to investigate systematically several teacher-program combinations to determine if there was a combination or combinations of teacher and program that afforded the most productive instructional interaction of these two instructional agents.

METHOD

During the school years of 1963 through 1965, over 90 high school teachers representing 63 school districts and 4,500 students in Pennsylvania cooperatively investigated five different teaching roles (or conditions) with programed instructional materials in first year algebra. Approximately two-thirds of the teachers used TEMAC programed texts while the others used SRA materials.

The teachers were assigned at random to one of five teaching Conditions. These classroom teaching Conditions were structured in the experimental design to constitute a sequence of graduated departures from the conventionally organized classroom.

In Condition I, the teacher continues to act as the main instructional agent, using programed materials in lieu of the traditional textbook, and maintaining typical classroom organization. The teacher introduces new topics, provides the necessary explanation, and then assigns material in the programed text that covers the class presentation. The teacher may also assign additional material to aid in thorough understanding. The pace of the class is restricted by the teacher and the concept of individualization is held to a minimum.

In Condition II, the daily presentations by the teacher are replaced by a two- or three-day overview of a topic or unit of instruction. Following this presentation, the student commences to use the programed material, working at his own pace, either in the class sessions or at home, until he reaches the assigned termination. Students who complete the assignment in advance of the time fixed are given the opportunity to work independently on related content matter and enrichment material.

The Condition III structure requires the teacher to assign a section or unit of the program to be completed by the student on a specific date. At that time, the teacher reviews, organizes, and synthesizes the material, and offers a variety of examples and applications. If the student completes the program prior to the assigned date, he is given opportunity to explore other facets of the content through supporting enrichment materials. In many respects this structure is the reverse of Condition II. It should also be noted that the three teaching Conditions described thus far are basically teacher-paced situations.

Condition IV is a more evident departure from accustomed secondary school classroom practice. In this situation, the teacher organizes the students into small groups as determined by the pace and mastery of the students on the programed materials. In the seminar groups, the teacher reviews the previously learned material, synthesizes, and prepares the students for the next unit of instruction. Student discussions and demonstrations are also encouraged. For special presentations on relevant enrichment material, the teacher may call the entire class together for one or two days, but in general whole-group instruction is minimized and in the normal procedure of this Condition does not occur at all.

In Condition V, the teacher assumes a helping role and functions primarily as a guidance and resource person. There is no formal class instruction as such and the programed materials act as the main instructional agent. The students operate on an individual

study basis with the teacher available to offer aid on request. Each student paces himself and proceeds through the program at optimum speed. Conditions IV and V are both student-paced structures that eliminate whole-group instruction.

After a four-day, pre-experimental training workshop in August of 1963, the teachers spent the ensuing academic year teaching first-year algebra with the programed materials. Typically, each teacher instructed two classes in the assigned Condition on a ninth grade level. Four Saturday workshops were held during the year to exchange experiences, to share project data, to change or modify procedures, and to give the project staff opportunities for seminars with teachers who were assigned the same Conditions. Teachers were visited biweekly in their classrooms by one of the six-member project staff. The staff consultant, during these classroom visits, observed and assisted the teachers in remaining on schedule and within tolerable limits of the assigned teaching Condition.

A variety of student achievement tests and teacher and pupil attitude scales were administered during the year. A full listing of activities and instruments is given in the flow chart after page 5. Follow-up achievement tests and attitude scales were administered in January 1965 to 85 per cent of the original student population approximately seven months after the final algebra exams.

RESULTS

Description of Experimental Teachers and Students

Table 1 indicates the number of teachers who were included in the analyses in this report regardless of the grade level that the teacher taught. Only teachers and students for whom complete records were available were included. The numbers of teachers who taught ninth grade classes are indicated in the parentheses. Only eight teachers did not teach at least one ninth grade class.

Table 1

Teacher N by Condition and Program

	I	II	III	IV	V
TEMAC	12 (10)	10 (10)	11 (10)	8 (6)	11 (11)
SRA	7 (6)	6 (4)	6 (6)	3 (3)	4 (4)

TEACHER ASSESSMENT

	ADHERENCE	ATTITUDE
Aug. '63	Pre-experimental training of participating teachers	Inventory: programed instruction, methods, scheduling, individualization research (Likert-type inventory - 75 items)
		Pre-evaluation of 5 teaching conditions (Rating best-worst - 15 items)
		Impressions of educational research, programed instruction and individualization (Semantic differential 10-13-10 pairs)
Sept. '63		5 common pair
Oct. '63	Bi-weekly observations by field consultants - adherence-progress reports	
Dec. '63		Comparison programed materials and conventional texts (Rating scale - 30 items)
Jan. '64	Bi-monthly evaluation meetings of participating teachers	
Feb. '64		Impressions of educational research, programed instruction and individualization (Repetition of Aug. '63 instrument)
May '64	Questionnaire on classroom behavior (Forced choice - 11 items & Rating - 12 items) Respondents: Field consultants, teachers, total student population	Impressions of educational research, programed instruction and individualization (Repetition of Aug. '63 instrument)
	Q - sort by consultants: adherence, future participation, continued use of P.I. materials	Comparison programed materials and conventional texts (Repetition of Dec. '63 instrument)
	Consultant rating of teacher behavior and local classroom-community conditions (Rating scale - 21 items)	Open-end questionnaire: treatment conditions, student reaction, instructional values of programed materials
Jan. '65	FOLLOW-UP STUDY - 85% of original population	

STUDENT ASSESSMENT

ATTITUDE

Student Opinion Scale: impressions of mathematics
(Semantic differential - 30 pairs)

Comparison programed materials and conventional texts
(Same instrument as teachers)

Student Opinion Scale: impressions of mathematics - 30 pairs
(Repetition of Sept. '63 instrument)

Impressions of programed instruction
(Semantic differential - 10 pairs from above

Factor Analysis

Student Opinion Scale: impressions of mathematics - 15 pairs retained

Impressions of programed instruction - all 10 pairs retained

APTITUDE

California Test of Mental Maturity-Short Form
Language, Non-Language and Total IQ
Numerical Reasoning Sub-Tests 4 and 5

California Reading Test

ACHIEVEMENT

22 Unit Tests
6 Cumulative Review Tests

Modern Math Mid-Year Test: problems
Modern math student population only

Seattle Algebra Test: standardized, problems
Total student population

Lankton First Year Algebra Test:
Standardized, problems; total student pop.

Final Exam - Traditional and Modern Forms
Appropriate student populations
(Problems, taken after structured review

Review Examination: 1 part of each Form of May '64 Final Exam (Repetition)

Table 2 indicates the number of pupils who were included in the analyses regardless of grade (N = 3,209). The numbers in parentheses are the ninth grade students included (N = 2,667); 83 per cent of the students were ninth graders.

Table 2

Student N by Condition and Program

	I	II	III	IV	V
TEMAC	461 (353)	442 (422)	436 (353)	365 (249)	457 (423)
SRA	309 (259)	180 (86)	246 (246)	148 (148)	165 (128)

Tables 3 and 4 give the means and standard deviations for SRA and TEMAC I.Q. and reading scores respectively for the seventy-eight teacher units.

Table 3

$\bar{X}$ and Sd of I.Q. Scores by Condition and Program

		I	II	III	IV	V
TEMAC	$\bar{X}$	112.8	111.5	109.5	112.0	109.9
	Sd	3.1	4.4	9.5	6.1	4.4
SRA	$\bar{X}$	114.6	114.9	116.7	113.9	117.3
	Sd	3.9	6.9	3.2	3.6	6.4

Table 4

$\bar{X}$ and Sd of Reading Scores by Teaching Condition and Instructional Program

		I	II	III	IV	V
TEMAC	$\bar{X}$	64.9	63.0	62.2	63.5	61.8
	Sd	2.9	4.7	8.6	4.0	3.7
SRA	$\bar{X}$	67.1	68.5	68.8	67.9	69.7
	Sd	3.3	5.1	2.8	3.6	5.0

The amount and type of professional training for the teachers within each Condition were tested by the Chi Square statistic across Conditions. The findings indicate that the randomized assignment of teachers to Conditions did not result in any one group differing significantly from the others in amount and type of professional preparation.

Sampling and Statistical Procedures

In order to make generalizations about the results of the study, the teachers, who represented school districts which were willing to experiment and do classroom research, were randomly assigned to a treatment Condition. Since we were looking at two different programed texts--TEMAC (traditional algebra) and SRA (modern)--we have two experiments, or a simultaneous replication of one experiment. The results on the various student tests, whether achievement or attitude, for each teacher are expressed as an average for each teacher's students. For example, teacher #32 in Condition III had a total of 60 students in the study (two classes). The average performance for those 60 students on the Project Final Exam was 18.42. This average was used, along with other teacher averages in Condition III, to arrive at a grand average for all teachers in Condition III. These Condition averages were then statistically compared to the other Condition averages to determine if there were significant differences among the five Conditions.

Even though the teachers were assigned at random to the five teaching Conditions, some Conditions may have, at chance, received a larger proportion of teachers who had brighter, more interested students than did the other Conditions. In order to cancel out these possible advantages for certain Conditions, all students took a number of pre-experimental tests to determine their 1) I.Q., 2) reading ability, 3) math aptitude, and 4) attitude toward mathematics. By the statistical methods of analysis of covariance and multivariate analysis of covariance, the effects of I.Q., reading, math aptitude, and math attitude were cancelled out when final course achievement and attitude scores were analyzed. In other words, by this statistical method, all Conditions were adjusted so that they started out on an equal footing.

As previously indicated, a multivariate analysis of variance and covariance (MANOVA) was the major statistical tool used to analyze the data since most hypotheses included more than one dependent variable. For analyses with only one dependent variable, a standard univariate F test was employed. Each analysis tested the null hypothesis. The 0.05 level of confidence was selected as the level for reporting statistical significance.

In most cases, two separate analyses were performed to test each hypothesis. One analysis restricted itself to only ninth grade students and classes, the other analysis considered all students and classes regardless of grade level. No additional information was obtained from considering only ninth graders, therefore the results from the analyses using all grades are reported. All analyses reported use the teacher as the sampling unit.

Student Achievement

Are there significant differences in achievement among the five teaching Conditions using the TEMAC program when achievement is measured by the following dependent variables: 1) Seattle mid-year exam, 2) Lankton final exam, 3) Project final exam, 4) Follow-up exam, 5) Cumulative test 2, and 6) Cumulative test 4; and adjustment is made using the following covariates: 1) I.Q., 2) California reading score, 3) Initial teacher attitude toward programed instruction, 4) Initial teacher attitude toward educational research, 5) Initial teacher attitude toward individualized instruction, 6) Initial student attitude toward math, 7) Proportion of unit tests completed, and 8) Number of years teaching experience?

A one-way multivariate analysis of covariance indicated that there were no significant differences in achievement at the 0.05 level of significance among the different teaching Conditions ($F = 1.23$, $df = 24/123$).

Since the computer program used did not provide adjusted means for the dependent variables, separate univariate analyses of covariance were run to determine the adjusted means for 1) Lankton, 2) Project final, and 3) Follow-up. I.Q. and reading scores were used as covariates.

Table 5

Adjusted $\bar{X}$'s for TEMAC Lankton and Project Final by Conditions

Test	I	II	III	IV	V	F	df
Traditional Math Project Final	18.4	18.2	18.9	17.2	17.5	1.0	4/45
Lankton	28.2	28.7	29.4	27.7	27.6	1.0	4/45
Follow-up	8.3	8.2	9.1	8.0	8.1	1.4	4/45

Are there significant differences in achievement among the five teaching Conditions using the SRA program when achievement is measured by the following dependent variables: 1) Seattle mid-year exam, 2) Modern math midyear exam, 3) Lankton final exam, 4) Project final exam, 5) Follow-up exam, 6) Cumulative test 2, and 7) Cumulative test 5; and adjustment is made using the following covariates: 1) I.Q., 2) California reading score, 3) Initial teacher attitude toward programed instruction, 4) Initial teacher attitude toward educational research, 5) Initial teacher attitude toward individualized instruction, 6) Initial student attitude toward mathematics, 7) Proportion of unit tests completed, and 8) Number of years teaching experience?

A one-way multivariate analysis of covariance indicated that there were no significant differences in achievement at the 0.05 level of significance among the different teaching Conditions ($F = 0.82$, $df = 28/30$).

Since the computer program used did not provide adjusted means for the dependent variables, separate univariate analyses of covariance were run to determine the adjusted means for 1) Lankton, 2) Project final, and 3) Follow-up. I.Q. and reading scores were used as covariates.

Table 6

Adjusted $\bar{X}$'s for SRA Lankton and Project Final by Conditions

Test	I	II	III	IV	V	F	df
Modern Math Project Final	24.2	25.7	25.9	24.1	25.0	0.3	4/19
Lankton	29.9	30.9	30.6	31.1	31.9	0.6	4/19
Follow-up	11.2	12.7	10.5	11.2	11.4	1.1	4/19

Achievement test results were not significantly different among Conditions in either the TEMAC or SRA groups. In other words, students in all five of the teaching Conditions learned equally well. The fact that the achievement outcomes can be stated in a few sentences should not lead educators to minimize these results. These results suggest that the selection of one of the five teaching Conditions to be employed in classrooms should be predicated on criteria other than probable student achievement. For example, if teachers and administrators desire more student freedom and self-pacing of instruction, Conditions IV and V would, as the results of this study indicate, meet these criteria without a significant loss in student achievement.

Although none of the Conditions was compared to a traditional Condition--the teacher using a conventional textbook in the accustomed manner--there is some evidence to suggest that the programed material is at least equal to and perhaps superior to conventional textbooks.

The Lankton, a nationally standardized end-of-year algebra achievement test, has an expectancy chart in which pupil or class I.Q. level is plotted against final Lankton achievement. When we take the I.Q. level and the Lankton final for each of our Conditions and plot them on the Lankton Expectancy Chart, we find that, in general, the students in the study surpassed their counterparts in the norming sample.

Table 7

Per Cent of Norm Group of Comparable I.Q. Ability Surpassed by Project Conditions, TEMAC and SRA

	I	II	III	IV	V
TEMAC	58%	52%	63%	50%	48%
SRA[2]	50%	55%	50%	58%	62%

Student Attitude

To assess student attitudes toward mathematics and programed instruction, semantic differential measuring scales were constructed. For mathematics, a sixteen-item scale was developed with such polar word pairs as like vs. dislike, interesting vs. boring, and alive vs. dead. The eight-item scale for programed instruction had, for example, the following polar words: exciting vs. dull, alive vs. lifeless, and most vs. least. For each item, the most positive score was 1, the most negative 7. A neutral attitude would show up as a score of 4.0. For example:

	1	2	3	4	5	6	7	
like	( )	( )	( )	(X)	( )	( )	( )	dislike

There were no significant differences among the five Condition groups for either SRA or the TEMAC in initial attitudes of students toward mathematics.

Table 8

Student Attitude Toward Mathematics by Conditions: Pre-experimental[3]

	I	II	III	IV	V
TEMAC	2.6	2.6	2.5	2.6	2.6
SRA	2.6	2.5	2.4	2.8	2.5

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2 The Lankton was developed for conventional textbook material. Even so, the SRA students did exceptionally well.

3 For ease in interpretation, the figures shown in Tables 8 through 14 represent the average item score on the instrument. This is computed by dividing the total score on the scale by the number of items in the scale. Using 4.0 as a neutral position, one can quickly determine whether the attitude is positive (between 1 and 4) or negative (between 4 and 7).

Table 9

Student Attitude Toward Mathematics by Conditions:
End-of-Year

	I	II	III	IV	V
TEMAC	2.9	3.1	3.0	3.1	3.1
SRA	3.3	3.2	3.1	3.3	3.3

At the end of the year, there were still no significant differences among the Conditions for either TEMAC or SRA. However, the reader will note that in all cases the student attitudes were less positive than at the beginning of the year. Seven months later, on the follow-up tests, the student attitude remained approximately the same as it was at the end of the experiment.

Table 10

Student Attitude Toward Mathematics by Conditions:
Follow-up Study

	I	II	III	IV	V
TEMAC	2.9	3.2	3.1	3.3	3.2
SRA	3.4	3.2	2.9	3.1	3.1

The end-of-year student attitudes toward programed instruction were not significantly different among the Conditions; however, there were significant differences between SRA and TEMAC groups. We feel that this was due, in part, to the reading difficulty of the SRA material and the fact that SRA material was far more sophisticated than the TEMAC materials.

As pointed out before, the break point between positive and negative attitudes is 4.0. Even though there were no significant differences among Conditions, the reader can quickly see that in nine of the ten cases the students were negatively disposed toward programed instruction.

Table 11

Student Attitude Toward Programed Instruction by Conditions:
End-of-Year

	I	II	III	IV	V
TEMAC	3.7	4.3	4.6	4.9	4.3
SRA	4.2	4.6	4.6	4.9	4.8

The follow-up attitude test showed that the students were, in nine out of the ten cases, still negatively disposed toward programed instruction. The statistically significant difference between TEMAC and SRA remained over time. Apparently the SRA students remembered their strong feelings toward the material.

Table 12

Follow-up Student Attitude Toward Programed Instruction by Conditions

	I	II	III	IV	V
TEMAC	4.0	4.5	4.3	4.8	4.6
SRA	4.3	4.6	4.8	5.3	4.9

Teacher Attitudes and Reactions

Throughout the period of the study teacher attitudes were assessed by the same type of attitude scale as used for the students--the semantic differential. The teachers gave their impressions about each of the following concepts: 1) educational research, 2) programed instruction, and 3) individualization of instruction. There were no significant differences among Conditions and in all cases the teachers indicated a mildly positive attitude toward programed instruction.

Table 13

Teacher Attitude Toward Programed Instruction by Conditions (9 Items)

	I	II	III	IV	V
TEMAC					
Initial	3.4	2.9	2.8	2.7	2.9
Mid-Year	3.6	3.7	2.7	3.0	3.2
End-of-Year	3.2	3.4	2.8	2.8	3.2
SRA					
Initial	3.0	2.7	2.5	3.8	2.7
Mid-Year	2.0	3.0	2.7	3.5	3.0
End-of-Year	3.1	3.2	3.1	3.9	3.1

Likewise, the teachers responded positively toward "educational research" and "individualizing instruction." There were no significant differences among the Conditions at any time.

Table 14

Teacher Attitudes Toward Educational Research
and Individualizing Instruction
by Conditions

	Educ. Res.					Ind. Inst.				
	I	II	III	IV	V	I	II	III	IV	V
TEMAC										
Initial	2.9	2.4	3.0	2.9	2.5	2.6	2.6	2.1	2.3	2.1
Mid-Year	3.1	3.4	2.9	2.9	2.9	2.9	3.2	2.8	2.6	2.6
End-of-Year	2.7	3.1	2.9	2.8	3.0	2.4	2.6	2.9	2.3	2.9
SRA										
Initial	2.3	2.1	2.7	3.2	3.0	2.3	2.4	2.4	2.0	2.3
Mid-Year	2.4	3.1	2.4	3.3	2.9	2.3	2.7	2.7	4.0	2.6
End-of-Year	2.9	3.0	3.1	3.4	2.8	2.4	3.0	2.4	2.9	2.5

At the end of the teaching year, an open-ended questionnaire was administered to all teachers participating in the experiment for the purpose of getting unstructured attitudinal and evaluative responses to serve as a check on the validity of the data gathered by more formalized techniques. The questionnaire contained items like "specify the favorable and unfavorable aspects of the teaching Condition under which you taught this past year."

A preliminary reading of all filled-in questionnaires suggested that responses seemed to fall into three broad categories, each with two subsets. A classification scheme was developed, and two investigators working independently assigned each response, favorable and unfavorable, of each of the teachers by Condition to one or another of the six categories. The agreement of classifications between the two raters ranged from 81% to 86% across the five Conditions.

The SRA teachers by Condition did not respond in a way significantly different from the way in which the TEMAC teachers responded, consequently, all further analyses were done on all teachers as a group.

Teachers in Condition I were more favorable toward the instructional procedures called for by their Condition than the teachers in the other four Conditions. The results as shown in Table 15 were tested by Chi Square and the differences by Condition were found to be significant at the 0.01 level.

Table 15

Teacher Responses to Procedural Structure

Condition	Favorable	Unfavorable	Total
I	13	7	20
II	6	15	21
III	6	12	18
IV	6	10	16
V	1	11	12
	32	55	87

When the comments dealing with provision for variations in learning rate, need for enrichment, special interests, etc., were tallied under the general heading of individual difference, the data support the notion that Condition I is most rigid and the other Conditions increasingly more flexible. These differences, by Chi Square, are significant at the 0.01 level.

Table 16

Teacher Responses to Individual Differences

Condition	Favorable	Unfavorable	Total
I	2	16	18
II	8	3	11
III	12	5	17
IV	14	7	21
V	16	4	20
	52	35	87

Another analysis significant at 0.01 indicated that the teachers in Conditions IV and V found that they had to make a significantly larger number of accommodations than did the teachers in Conditions I, II, and III. This is consistent with the way the teachers felt about the Procedural Structure of their Conditions. (see Table 15)

Two rather remarkable inferences can be drawn from Table 17 showing responses categorized under Student Responses, dealing with student interest, motivation, attitudes, student behavior, etc. The

first of these is that more teachers made comments, favorable and unfavorable, about student response than about any of the other categorized topics, suggesting that teachers' attention is indeed focused primarily on student response. The other datum, which defies interpretation, is that no significant difference obtains among groups on this dimension. Favorable and unfavorable comments were divided about equally in all five Conditions. A cursory reading of the unfavorable comments turns up considerable repetition of the words "cheat," "boredom," "copy," and their synonyms and derivatives. This pattern suggests that many of the teachers found difficulty in maintaining a desirable level of student discipline when utilizing programed instruction.

Table 17

Teacher Responses to Student Response

Condition	Favorable	Unfavorable	Total
I	6	6	12
II	9	10	19
III	12	15	27
IV	11	15	26
V	7	17	24
	45	63	108

When asked to "design a Condition VI which you would regard as the most effective mode of program utilization for your teaching with programed instruction next year," the teachers tended to design a Condition which closely approximated the Condition under which they operated during the past year. However, to show how some teachers jumped to other Conditions, a percentage was struck of the most frequent "ideal" Condition. Twenty-five per cent of the teachers opted for Condition I; twenty-three per cent for II; twenty per cent for III; fifteen per cent for IV; and seventeen per cent for V.

The question "Are you going to recommend the use of programed materials next year?" received the following responses: 57 yes; 22 no; and 11 questionable.

Sixty-seven per cent of the teachers indicated that they would be willing to participate in a research project next year on programed instruction, and, interestingly, seventy-seven per cent indicated they would participate if the project did not involve programed instruction.

Other Findings

1. Teacher attitudes toward programed instruction, educational research, and individualizing instruction each affected student achievement on the final achievement measures. The more positive the teacher attitude, the better the student test performance.

2. Brighter students had more positive attitudes toward mathematics.

3. In order to determine if some Conditions were more effective than others for students of varying I.Q. bands, elaborate factorial tests were conducted. As expected, brighter students achieved more than slower students, but there were no significant differences or interactions among Conditions for each intelligence quartile.

4. The best single predictor for student achievement in both the SRA and TEMAC program Conditions was the California reading test raw score. For TEMAC, the correlations between Reading and Project Final, and Reading and Lankton were 0.53 and 0.67, respectively. For the same variables for the SRA Conditions, the correlations were 0.55 and 0.61, respectively.

If reading scores were not available, the next best single predictor would be the California Test I.Q. For TEMAC, the correlations between I.Q. and Project Final and Lankton were 0.47 and 0.62, respectively--approximately 0.05 below the reading test level. For the same variables for SRA, the correlations were 0.49 and 0.57, respectively--again approximately 0.05 below the reading test level.

When the additional predictor variables of I.Q., student math attitude, Factor 1, and either teacher attitude toward educational research or programed instruction were added to the reading test in a multiple prediction equation, the multiple correlations rose to between 0.61 - 0.63 for predicting Project Final scores and between 0.69 - 0.71 for predicting the Lankton scores.

DISCUSSION

Most investigators, in a study like this, are discouraged when the results are not statistically significant. They feel that they wasted a great deal of time, effort, and money to find nothing. It was not too long ago when some departments in major universities did not grant doctoral degrees unless the candidate found a significant difference in his dissertation research!

Our study had no exciting statistical differences. With the exception of a few significant differences between the SRA and TEMAC groups, the differences among the treatment Conditions remained small and insignificant.

But in this study, the finding of no significant differences among Conditions is, in itself, educationally significant for the use of programed instructional materials.

This study has shown that programed instructional materials can be used in at least five different ways without significantly altering student achievement or attitude. It also indicates that very flexible arrangements (as in Conditions IV and V) are as productive as the fairly rigid procedure prescribed by Condition I. For example, Condition I was the methodology closest to typical teacher-led classroom instruction. The only variable that was changed was the substitution of a programed test in place of the conventional textbook. Even though the student achievement differences among Conditions were not statistically significant, there are some achievement differences, with respect to Condition I, which are worth noting. In the TEMAC group, the best Lankton scores were achieved by Condition III, closely followed by II. (see Table 5) Again on the Project Final for the TEMAC group, Condition III emerged as the highest. For the SRA groups, Condition V was highest on the Lankton, followed, in progression, by Conditions IV, III, II, and finally I. (see Table 6) For the SRA group on the Project Final, Conditions III and V were tied for high, followed by II, IV, and last, I. These data are reviewed only to impress on teachers and administrators that variations from rather stilted and conventional instruction as represented by Condition I can produce comparable results.

These data suggest to us that administrators and department chairmen should be cautious before prescribing a set instructional procedure for all teachers. The findings should also support any program or proposed program for establishing independent study areas where students can proceed at their own rate and interest. One student in Condition V, with an I.Q. of 126, finished three years of modern math in one year. He had both the opportunity and the materials. Other students found Condition V, for example, to be intolerable. They needed (or at least perceived that they needed) continual direction and scheduling from the teacher.

Students, teachers, parents, and schoolmen have long known, either from empirical observations or intuition, that those teachers who have positive attitudes toward new ideas and interest in professional activities are those teachers who bring out the best performance in students. The data from this study support this assumption. Those teachers who had positive attitudes toward educational research, programed instruction, and the individualizing of instruction tended to get better student performance.

Another interesting sidelight is the ability to which students can accurately describe a teacher's classroom behavior over a school year. Although we had consultants in the classrooms on the average of at least twice a month to observe the teachers, we wanted an independent reading about the teachers' adherence to Conditions. A forced choice scale was constructed in which the students selected the best descriptors of the way their teacher taught the programed material. The scale was constructed so that if a teacher had remained in Condition, the students' responses would make a certain profile which fit that Condition. From these data, and the consultants' observations, we eliminated several teachers (and their student scores) from the statistical analyses. The student analyses of their teachers' adherence to Conditions related exceptionally high with our observers' observations and recommendations.

On this same scale we solicited student reaction on a four point scale--Frequently, Occasionally, Seldom, and Never--to the following statements: I was bored by the program; I wished that I had used a regular textbook this year. Inspection of Tables 18 and 19 reveals that, in general, as the Conditions departed more and more from traditional instruction, the students tended to become more bored and desirous for the old ways of instruction.

To us this implies that if a school system is to go into such areas as individualizing instruction, independent study, etc., it should move cautiously toward these objectives. A quick, dramatic change from accepted procedures, even though the new methods are more sensible and educationally sound, may cause student and teacher rejection of the new in favor of the old. Conditions IV and V were radical departures from conventional procedures. Had these two Conditions evolved slowly rather than being forced quickly as was done in this study, the student attitudes may have been more favorable.

Teachers tend to say the right things. For example, the teachers were very positive toward the concept of individualizing instruction (see Table 14) and they also perceived, at the beginning of the study, Condition I to be the worst Condition for providing for student individual differences and V and IV to be the best. And yet, at the beginning of the study when asked "the Condition I would want for this year," Conditions I and II were selected almost two to one in favor of either IV or V. In fact, 50 out of the 85

Table 18

Per Cent of Student Response to the Statement
"I wished that I had used a regular textbook this year"

Condition	% Frequently	% Occasionally	% Seldom	% Never	Total N
TEMAC					
0	34	18	26	20	349
2	35	20	24	19	212
4	43	22	21	13	288
6	56	19	14	9	250
8	47	20	21	12	259
Total	43	19	21	15	1,358
SRA					
1	27	18	25	28	520
3	43	18	18	21	530
5	45	21	17	15	520
7	47	21	17	13	710
9	52	18	16	12	550
Total	43	20	18	17	2,830

Table 19

Per Cent of Student Response to the Statement
"I was bored by the program"

Condition	% Frequently	% Occasionally	% Seldom	% Never	Total N
TEMAC					
0	24	27	35	12	351
2	29	32	28	10	212
4	33	24	30	11	289
6	37	29	27	4	253
8	38	27	26	7	264
Total	32	28	30	9	1,369
SRA					
1	17	23	39	20	527
3	30	23	34	12	534
5	32	28	29	9	528
7	36	27	26	9	714
9	35	28	27	7	554
Total	31	26	31	11	2,857

responding teachers (59%) indicated that Conditions IV and V would be the worst possible Conditions to be assigned! These findings are supported by analysis of another question which asked, "The Condition I like best and the Condition I like least." Almost 70% found IV and V to be the "least"! Only 32% found IV or V to be the "best." When asked to select the Conditions which allowed for the most student-teacher interaction, Conditions IV and V polled 75% of the teachers. We assume that individualized instruction included a great deal of student-teacher interaction. We expose these data only to emphasize that what teachers say about their desires to deal more closely with the individual student and to provide for individual differences are not necessarily what they would do given the opportunity and situation.

This observation is confirmed by reinspection of Table 15, Teacher Responses to Procedural Structure. As most of the variance is accounted for by the responses of the teachers in Condition I, it may be inferred that more teachers in Condition I were satisfied with the requirements of the procedure than were the teachers in the other Conditions. Teachers in Condition V, by contrast, tended to take an unfavorable view of the requirements of the procedure. More teachers in II, III, and IV responded unfavorably than favorably, but not quite so overwhelmingly as did those in Condition V. These data imply that the further teachers are asked to deviate from normal teaching methods, the more they look with disfavor on the proceedings.

CONCLUSION

We must find ways of putting those students who can work independently in contact with the right materials and instructional styles. Diagnostic procedures should be developed so a variety of teaching conditions can be available for both teachers and students. For some teachers and some students each Condition had a high pay-off; for others, the same Condition was an abomination. We believe that this study has shown, rather conclusively, that teachers and students can break out of conventional instruction and still achieve and perform equal to or better than typical lock-step instruction. No one Condition was outstanding. This is the significant finding of Project 1120.

SUMMARY

This study investigated five different teaching strategies (Conditions) for classroom year-long utilization of programed instructional materials in first year algebra. The teaching Conditions ranged on a continuum from rigid classroom organization and teacher-controlled student pace to flexible organization and student-determined pace.

Ninety teachers, instructing 4,500 students, were assigned at random to one of five Conditions. Approximately two-thirds of the teachers used a program in traditional algebra (TEMAC) while the others used a modern math program (SRA). The TEMAC and the SRA groups were analyzed independently as a simultaneous replication of the same experiment.

There were no pre-experimental differences among Conditions with respect to student intelligence, reading ability, math aptitude, and attitude toward math. Amount and type of teacher background and experience also were not significantly different across Conditions.

Multivariate analysis of covariance was the major statistical procedure used. All analyses used the teacher as the sampling unit.

There were no significant achievement differences among the five teaching Conditions for either the TEMAC or SRA groups on seven dependent achievement variables when adjustment was made on eight covariates.

There were no significant differences among the five Conditions for either end-of-year student attitude toward mathematics or programed instruction for either TEMAC or SRA groups.

There were no significant differences among the five Conditions on end-of-year teacher attitudes toward programed instruction, individualization of instruction, and educational research.

Teachers tended to make more unfavorable comments about those teaching Conditions which departed farther from traditional modes.

Teacher attitude affected student achievement. There were no significant interactions between I.Q. levels and Conditions. Reading scores were the best single predictor of math achievement.

The main conclusions were that programed instruction can be used in at least five different ways without significantly altering student achievement or attitude, and that both students and teachers can depart from conventional modes of instruction.

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